Vitamin Plays Key Role In Flavor of Milk

MARK KEENEY

A cold glass of milk—in Albuquerque, Bangor, Kansas City, or Seattle—we take it for granted—in the airport, factory, or school. Surely, this is one of the great testimonials to agricultural progress. Milk, the most perishable of all agricultural products, is distributed anywhere you travel in the United States.

What is behind this remarkable saga? Art and science—pure art and science. The ancients developed the art of making cheese and butter from that perishable product of their herds, milk. These were the major products of milk until the 20th century when the newly developing sciences of bacteriology and biochemistry began to be applied to milk utilization.

Concepts of Louis Pasteur, the 19th century father of bacteriology, were applied in the first two decades of this century in developing the heat treatment of milk known as pasteurization. This was the key breakthrough leading to the present wide availability of a glass of milk. Pasteurization not only destroyed pathogenic organisms like those causing tuberculosis, scarlet fever, and typhoid, it also prolonged the keeping quality of milk, from a flavor standpoint, from a few hours to a few days at refrigerator temperature. This was so because pasteurization inactivated the natural nonpathogenic micro-organisms and enzymes of milk which, if left unchecked, would result in sour, putrid, and rancid flavors.

The advent of pasteurization, supplemented by the parallel development of mechanical refrigeration, spawned the modern dairy industry. During this development, many new technical problems appeared. The early pasteurized milk was plagued by an objectionable flavor—variously described as cardboard, cappy, metallic, or tallowy. Scientific study of the flavor defect revealed that it resulted from oxidation of the lipid (fat) components of the milk. Major catalyst of the oxidation was found to be the trace amounts of copper picked up in the milk from the copper alloy utensils commonly used at that time to handle milk. A shift to the use of stainless steel and glass to handle milk eliminated the source of copper contamination.

Despite the great improvement in flavor stability from the elimination of copper contamination, unpredictable outbreaks of oxidized flavor still occur. During the past two decades, it has been demonstrated that copper contamination is not the only factor involved in flavor development. Milk from certain individual cows will develop a strong oxidized flavor within 1 day even when it is known from careful analysis that there is no copper contamination.

Variations in the normal biochemical components of milk have now been implicated in this problem.

MARK KEENEY *is Professor of Dairy Science at the University of Maryland, College Park.*

A radical change has taken place in the method of handling milk in recent years. When the milk was stored and moved from the farm to the dairy plant in 10-gallon cans, it was picked up every day. Now, with the complete conversion to cold wall farm tanks for storing milk, it is picked up every 2 or 3 days. The milk is older by the time it reaches the processing plant. This is a significant factor, too often overlooked by those searching for causes of modern milk quality problems.

This factor of the extra age of raw milk, coupled with the evidence that oxidized flavor development is related to feed-dependent biochemical milk components, presents a new type of problem requiring new solutions. Historically, there has been sharp division between the interest of the milk producer and the milk processor. Milk production was considered a separate discipline from that of dairy manufacturing. It was reflected in many land-grant universities where there were separate curriculae, faculties, and departments in these two areas. The Government laboratories followed the same division, and there are still different laboratories for production research and utilization research. The oxidized milk problem is a classic example of one that cannot be solved with this sharp division of production and product research.

Raymond L. King became interested in the problem of oxidized milk flavor while a graduate student at the University of California in the mid-1950's. He has maintained an intensive research program on the problem since joining the University of Maryland faculty in 1958. He brought the intellect of a Phi Beta Kappa graduate in chemistry to bear on the problem. His chemical attack on the problem kept leading him back to the cow, and things that were happening before the milk was produced.

The Dairy Science Department at Maryland never has had a sharp division between the production and product specialists, so he was in a good environment to go beyond the cow to look for answers. Other scientists had similar experiences, so the Dairy Products Laboratory of the U.S. Department of Agriculture gave King a research grant in 1965 to pursue this problem of the effects of milk production practices on the susceptibility of milk to develop oxidized flavor.

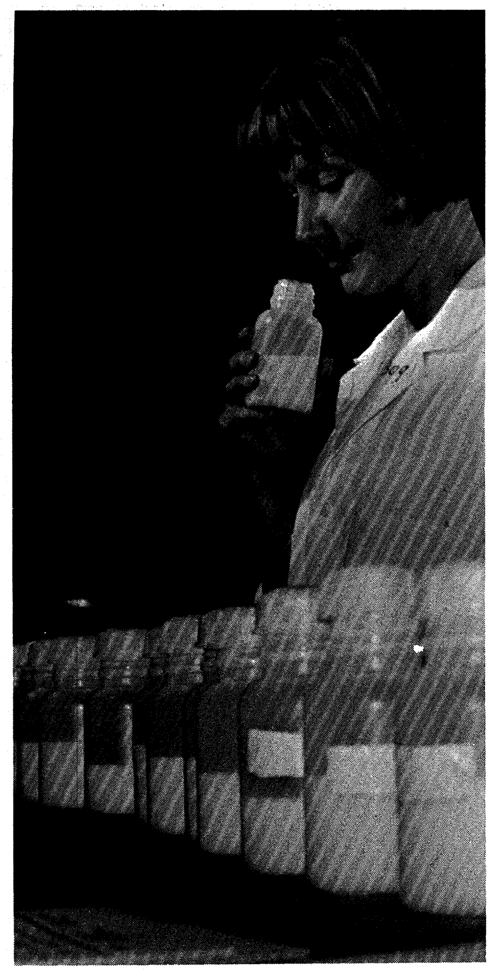
A research herd of 22 Holsteins was selected from the first calf heifers over a 6-month period. The herd was housed the year round in a stanchion barn at the university's Agronomy-Dairy Forage Research Farm, where control could be exercised over feeding and management of the herd.

Initial work with this herd confirmed the widely held belief that dry feed (hay and grain) produces milk susceptible to oxidized flavor development, while green feed (pasture and silage) produces resistant milk. In trying to find the reason for the distinct difference, the first lead has paid off with remarkable success. Krukovsky of Cornell had shown in the early 1950's that vitamin E is an important variable in the forage crops. It is now generally believed that the major function of vitamin E is to serve as a biological antioxidant in both plants and animals. With this background information, King made a thorough study of the role of vitamin E in the oxidized flavor problem.

He found that the addition of alpha-tocopherol acetate, a stable form of vitamin E, to dry rations increased the vitamin E content of the milk in direct proportion to the amount fed and that such milk was resistant to oxidized flavor development. Removal of the vitamin E supplement from the dry ration resulted in rapid decline in the vitamin E content of the milk and reappearance of oxidized flavor. Further study by King of the vitamin E content of various feeds showed conclusively that those feeds which result in oxidized flavor are poor sources of vitamin E and conversely that the feeds which result in stable milk are good sources of vitamin E.

He has made the important practical observation that methods of harvesting

Prof. Raymond L. King analyzes milk *left,* for vitamin E content. University of Maryland graduate student, *below*, scores milk samples for flavor and odor.



and preserving forages have a profound effect on the vitamin E content.

Some green forages were excellent sources of vitamin E while others were poor. Alfalfa appeared to fall into both categories. The first cutting of the season was a relatively poor source of vitamin E while a late cutting was an excellent source.

Alfalfa hay loses most of its vitamin E during conventional curing, even in barn curing. Ensiling should be an effective means of storing vitamin E-rich forage for winter feeding. Commercial dehydration is also an effective means of preserving the vitamin E content of forages.

The current status of King's research indicates that oxidized flavor can be controlled by providing sufficient vitamin E in the dairy ration. A daily intake of 1 gram is sufficient. This amount can be provided by proper selection of natural feeds or by supplementation with alpha-tocopherol acetate or a combination of both. Alfalfa hay and probably most hays are poor sources of vitamin E. But dehydrated alfalfa and grass or alfalfa silages are likely to be good sources of the vitamin.

An oxidized-flavor problem can be corrected within 2 or 3 days through providing a large single oral dose of alpha-tocopherol acetate (7 grams) followed by regular daily intake of 1 gram of the vitamin. There appears to be no significant storage of vitamin E in the dairy cow; therefore, a constant daily intake is required. King suggests that oxidized milk flavor may be the cow's way of expressing a need for vitamin E.